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Intro Energy Technologies Syllabus
This course introduces the energy technologies in use today, and those that are in the research stage as possible alternatives. This course is aligned with the textbook "Energy and the Environment" by Ristinen/Kraushaar.
Instructor: Lee McMains

Syllabus: Introduction to Energy Technologies

Course Description

Introduces the energy technologies in use today and those that are in the research stage as possible alternatives. Presents technologies including active solar heating, passive solar heating, wind energy systems, biomass, photovoltaics, co-generation, low and high head hydro, hydrogen geothermal, power towers and energy storage systems.

Standard Competencies

Demonstrate through practical exercises, written assessments, and examinations a thorough knowledge of:

- The Principles of Energy Production and Use
    - Active and Passive Solar Systems
    - Bio-Mass
    - Co-Generation
    - Geothermal
    - Electrical Power Generation
- The Principles of Energy Storage

Textbook

Energy and the Environment, Ristinen/Kraushaar

Week	Module	Reading	Exams

1-3	One: Energy Forms and Units	p. 1-27	
4	Two: Heat Engines	p. 63-67, 72-79	
5	Three: Heat Pumps	p. 79-82	Exam One (M1-M3)
6	Four: Power Generation	p. 67-72	
7	Five: Fossil Fuels	p. 31-57	Exam Two (M4-M5)
8-9 9-12	Six: Alternative Energy I - Solar Alternative Energy II - Non-Solar	p. 90-120 p. 124-165	Exam Three (M6-M7)
13	Eight: Conservation	p. 210-239	
14-15	Nine: Transportation and Air Pollution	p. 244-282, 287-321	
16			Final Exam (M8-M10)

Schedule

Module 1: Energy Forms and Units
This course introduces the energy technologies in use today, and those that are in the research stage as possible alternatives. This course is aligned with the textbook "Energy and the Environment" by Ristinen/Kraushaar.
Instructor: Lee McMains

Introduction and Instructions

In this module we will develop a meaning of the word **energy** and identify the different ways to express it.

Objective and Big Questions

At the completion of this module you should be able to:

- Understand the different forms in which energy exists.
- Convert between different forms.

As you work through this module please keep the following questions in mind:

- What forms of energy do I (the student) use?
- Which are the intuitive forms of energy, and how can I convert from less obvious forms into these more intuitive forms?

Timeframe

We will spend 2 weeks on this module.

Reading

For this module, please begin by reading pages 1-27 of the textbook. Be sure to read the tables, look at the figures, and study the examples.

3 Minute Masteries

Please review (read the text and watch the associated video) the 3-Minute

Masteries (3MMs) for this module which closely emulate in-class lectures (only much shorter!)

1. Where Energy is Found and How It's Used
2. Forms of Energy I
3. Forms of Energy II
4. Units of Energy
5. Equations
6. Scientific Notation
7. How to Convert From One Unit to Another I
8. How to Convert From One Unit to Another II

Assignment
Complete a reference card that converts between the various energy units we cover in this course.

https://cnx.org/content/m47646/

Instructions for completing this card are located here.

Module 2: Heat Engines
This course introduces the energy technologies in use today, and those that are in the research stage as possible alternatives. This course is aligned with the textbook "Energy and the Environment" by Ristinen/Kraushaar.
Instructor: Lee McMains

Introduction and Instructions

In this module we will explore the concept of heat engines and look for common, everyday examples.

Objective and Big Questions

At the completion of this module you should be able to:

- Explain how a temperature difference can be used to do useful work.
- Explain how a heat engine works.
- Explain the differences between various internal combustion and external combustion engines.

As you work through this module please keep the following questions in mind:

- Can a heat engine be 100% efficient?
- What do these diverse engine designs have in common?
- How does each engine type exploit the temperature difference?
- What are the limitations of the engine types?

Timeframe

We will spend 1 week on this module.

Reading

For this module, please begin by reading pages 63-67, 72-79 of the textbook. Be sure to read the tables, look at the figures, and study the examples.

3 Minute Masteries

Please review (read the text and watch the associated video) the 3-Minute Masteries (3MMs) for this module which closely emulate in-class lectures (only much shorter!)

1. Mechanical Equivalent of Heat I
2. Mechanical Equivalent of Heat II
3. How to Express 'Efficiency'
4. Temperature Difference and Available Work
5. Ways to Exploit a Temperature Difference

Assignment

PowerPoint: Heat Engine

Module 3: Heat Pumps
This course introduces the energy technologies in use today, and those that are in the research stage as possible alternatives. This course is aligned with the textbook "Energy and the Environment" by Ristinen/Kraushaar.
Instructor: Lee McMains

Introduction and Instructions

In this module we will consider heat pumps, and discern how they're different than heat engines.

Objective and Big Questions

At the completion of this module you should be able to:

- Describe the compression refrigeration cycle.
- Understand other methods of cooling.
- Understand other methods of cooling.
- Apply the Coefficient of Performance to determine heat pump efficencies.

As you work through this module please keep the following questions in mind:

- Can a heat engine be 100% efficient?
- How does the refrigeration cycle work?
- Of two different air conditioning units, which is "better"?

Timeframe

We will spend 1 week on this module.

Reading

For this module, please begin by reading pages 79-82 of the textbook. Be sure to read the tables, look at the figures, and study the examples.

3 Minute Masteries

Please review (read the text and watch the associated video) the 3-Minute Masteries (3MMs) for this module which closely emulate in-class lectures (only much shorter!)

- Temperature Difference and Used Work
- Thermodynamics of Heat Pumps
- Coefficient of Performance
- Ways to Create a Temperature Difference I
- Ways to Create a Temperature Difference II

Discussion
Read this article on heat pumps.

Based on your knowledge of how heat pumps work (they do work to move heat), which of the advancements mentioned do you think would be best for Colorado?

Module 4: Power Generation
This course introduces the energy technologies in use today, and those that are in the research stage as possible alternatives. This course is aligned with the textbook "Energy and the Environment" by Ristinen/Kraushaar.
Instructor: Lee McMains

Introduction and Instructions

In this module we will examine how electric power is generated, as well as how it's transmitted.

Objective and Big Questions

At the completion of this module you should be able to:

- Explain how heat engines are used to generate electricity at the commercial level, including a few comments on generators and induction.
- Explain how power is transmitted to residences and businesses, including a few comments on high-voltage vs. low-voltage.

As you work through this module please keep the following questions in mind:

- What kind of energy is safe in the home?
- How does energy get in my home?

Timeframe

We will spend 1 week on this module.

Reading

For this module, please begin by reading pages 67-72 and 82-84 of the textbook. Be sure to read the tables, look at the figures, and study the examples.

Watch the following videos:

- The History of Thomas Edison - a Short Story
- The History of Nikola Tesla - a Short Story
- Magnetism: Induction
- Magnetism: Electromagnets
- Magnetism: Transformers

Assignment
Case Study Summaries

Read two case studies about power generation and provide summaries. Both summaries should be included in one document.

This assignment will be graded per the following rubric:

https://cnx.org/content/m47731/

Please review both of the following case studies from "Crossing the Energy Divide: Moving From Fossil Fuel Dependence to a Clean Energy Future", by Robert and Edward Ayres, ©2009 Pearson.

- Chapter 2: The Hidden Gold of Energy Recycling
- The CLECO Monopoly, beginning on p. 95

For each case study write a brief summary and include the following information:

- All of the major players.
- Their objectives.
- Their plans-of-action that achieve said objectives.
- Whether their objectives were met.

If you're unsure of how to proceed, read How to Analyze a Case Study for more information. Don't try to answer every question asked in that guide - those are generic examples. Do expect to give each case study a sufficient amount of thought and analysis. Further, expect to make recommendations based on your reading and analysis. For an example of a case study summary, please see the Project summary report for Moving Beyond NIMBYism.

One well-written page should be sufficient for this assignment.

Module 5: Fossil Fuels
This course introduces the energy technologies in use today, and those that are in the research stage as possible alternatives. This course is aligned with the textbook "Energy and the Environment" by Ristinen/Kraushaar.
Instructor: Lee McMains

Introduction and Instructions

In this module we will examine the energy sources in the "fossil fuels" category, how they're formed, how they're produced (extracted), and their energy densities.

Objective and Big Questions

At the completion of this module you should be able to:

- Describe the differences between oil, natural gas, shale, and coal: how each is formed, produced, and used.
- Describe how crude oil is refined to form gasoline and other ready fuels.
- Explain the different energy densities of each type of fossil fuel discussed.

As you work through this module please keep the following questions in mind:

- How are these formed, and what use do they have?
- What are the relative energy densities of these sources?
- What are the relative energy densities of these sources?
- What are their inherent limitations?

Timeframe

We will spend 2.5 weeks on this module.

Reading

For this module, please begin by reading pages 32-57 of the textbook. Be sure to read the tables, look at the figures, and study the examples.

Study

- **The Biogenic Theory**
- View the section entitled "The Kitchen" from **Oil Field Formation**.
- **Formation of Natural Gas**
- Geologists use the term *shale* to describe any sedimentary rock that is formed from silt and other small particles. In many ways, that definition applies to the Oil and Gas Industry, but we talk specifically of *oil shales*.

  The Bureau of Land Management has an informative page **About Oil Shale**.

Assignment
Watch **The History Channel's "Crude"**.

As you watch the video, please answer the questions in the following worksheet. You will find that the questions and the video progress in parallel, meaning you won't need to jump around. If you find that you have to skip a question to stay current with the video, then it would be advisable to back up a bit. Submit the worksheet when completed.

https://cnx.org/content/m47732/

Module 6: Alternative energy
This course introduces the energy technologies in use today, and those that are in the research stage as possible alternatives. This course is aligned with the textbook "Energy and the Environment" by Ristinen/Kraushaar.
Instructor: Lee McMains

Introduction and Instructions

In this module we will explore how much power is available from alternative energy sources and how we can (and do) capture it to do work and provide comfort. We define *alternative* as alternative to fossil fuels.

Objective and Big Questions

At the completion of this module you should be able to:

- Explain how the sun can be used to generate power, both electric and non-electric.
- Discuss how solar cells (PV) work.
- Demonstrate how to incorporate passive solar in daily life.
- Explain how wind, geothermal, wave, tidal, biomass, and hydrodynamic energy sources are used as fuel sources.
- Discuss the different (and emerging) technologies that exploit alternative energy sources.
- Explain which energy sources are designed for commercial use and which have applications at the residential level.

As you work through this module please keep the following questions in mind:

- What are the proper uses and capabilities of these technologies?
- What are the risks associated with their use?
- What are their inherent limitations?
- Will their improvements come from expanded use, new applications, new materials, or different technologies?
- What is the difference between "alternative" and "renewable"?

Timeframe

We will spend 5 weeks on this module.

Reading
For this module, please begin by reading pages 90-120 and 125-165 of the textbook. Be sure to read the tables, look at the figures, and study the examples.

Study

- **Bill Gross on New Energy**.

Assignments
Non-Solar Energy Source PowerPoint

Please create a 2-page PowerPoint presentation about one of the non-solar alternative energy sources we discuss in this module (including any that we haven't yet talked about.

Pick the one that you are most interested in learning about; one slide should introduce the technology (how it works, etc) and the second should discuss the benefits and limitations (or risks) of the technology.

Case Study Summaries

Read the two articles below about non-solar alternative energy and provide summaries. Both summaries should be included in one document.

This assignment will be graded according to the following rubrics:
https://cnx.org/content/m47733/

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Please review both of the articles below, then write a brief summary and include the following information:

- The type of non-solar alternative energy discussed.
- The major point(s) of the article.
- A summary of the mechanics of the processes involved.
- Include your recommendations based on your reading and analysis.

Crop Residue May Be Too Valuable to Harvest for Biofuels

Harnessing Landfill Gas in Erie for Power Production

One well-written page should be sufficient for this assignment.

Module 7: Energy Conservation
This course introduces the energy technologies in use today, and those that are in the research stage as possible alternatives. This course is aligned with the textbook "Energy and the Environment" by Ristinen/Kraushaar.
Instructor: Lee McMains

Introduction and Instructions

In this module we will explore methods of planning and management to conserve energy.

Objective and Big Questions

At the completion of this module you should be able to:

- Demonstrate how effective planning and energy management can affect personal comfort, profitability, and sustainability.

As you work through this module please keep the following questions in mind:

- What can I do differently to reduce energy consumption in my everyday life?
- What will I have to give up to accomplish this, and is it worth it?

Timeframe

We will spend 1 week on this module.

Reading

For this module, please begin by reading pages 210-239 of the textbook. Be sure to read the tables, look at the figures, and study the examples.

Module 8: Transportation and Air Pollution
This course introduces the energy technologies in use today, and those that are in the research stage as possible alternatives. This course is aligned with the textbook "Energy and the Environment" by Ristinen/Kraushaar.
Instructor: Lee McMains

Introduction and Instructions

In this module we will explore current transportation systems, innovative transportation models, and the effect of moving goods and people on the environment. We will also explore how air pollution forms on this planet, its effect on the many ecosystems, and attempts to curb man-made pollution.

Objective and Big Questions

At the completion of this module you should be able to:

- Discuss the energy use involved in moving goods and people.
- Identify limitations of current technology.
- Discuss potential modes of travel.
- Describe human-environment interactions
- Address negative environmental responses

As you work through this module please keep the following questions in mind:

- How do I use energy to move my goods and family?
- Are there things I can do differently to achieve the same results with less energy?
- How much impact do humans really have on a global environment?
- Should I be worried about any of theses pollutants where I live?
- Why do some say that global warming is a myth, while others insist it's backed up by data?

Timeframe

We will spend 2 weeks on this module.

Reading
For this module, please begin by reading pages 244-246, 254-271, 279-281, 287-310, and 315-321 of the textbook. Be sure to read the tables, look at the figures, and study the examples.

Study
Please read this 2004 press release from Princeton University: **Emission of smog ingredients from trees is increasing rapidly**.

Assignment
Final Essay - Transportation

We have learned about the external combustion engine as well as the internal combustion engine; now we'll move away from combustion entirely.

For this paper please answer the following question:

What should our transportation system look like 50 years from now?

To answer this question, it may be helpful to consider how people and goods might be transported in the future, and whether there is a single solution for both long and short distances.

You are encouraged to review chapter 8 of your textbook as well as news articles that include or are similar to those found at: **Cars**
Intelligent Community Vehicle System
Rail News
Bus and Motorcoach News
Plane News
Bicycling
NASA Plan for Private Space Taxis Hasn't Won Over Lawmakers

Topics for possible analysis include congestion, urban sprawl, new urbanism, fuel sources, design engineering, ride sharing, or just about anything transportation-related. If you’re uncertain, just ask.

Find a topic, find a position on that topic, and defend it. Try to guess what someone with an opposite opinion might say; use that to strengthen your position.

Take what you’ve learned about energy this semester (combined with your enhanced critical thinking skills) and project where you think we might be, where we should be, and how to get from one to the other.

The final paper should not be less than two pages. Please see the following rubric for the scoring mechanism.
https://cnx.org/content/m47735/